Environmental Monitoring

Project title: Development of an Empirical Model for Predicting the Stream Invertebrate Fauna of the Greater Yellowstone Ecosystem: A Pilot Study

Principal investigator: Dr. Chuck Hawkins
Phone: 435-797-3525
Email: micajah@cc.usu.edu
Address: Department of Fisheries and Wildlife
Utah State University
Logan, UT 84322

Additional investigators: Trey Simmons

Objective: The objectives of this study are to develop an accurate, sensitive, and ecologically meaningful method to assess the biological integrity of streams in the Greater Yellowstone Ecosystem (GYE). By collecting physical habitat data and benthic macroinvertebrate samples from a large number of relatively pristine streams, most of them located in Yellowstone National Park, we can use multivariate statistical methods to generate a mathematical model that predicts the macroinvertebrate species composition at a potentially impaired stream. Comparison of the expected species composition (based on modeling) with that actually found at such a stream allows us to draw inferences about the biological integrity of the stream. The GYE is the largest relatively intact ecosystem remaining in the lower 48, but is under considerable pressure from urbanization, as well as traditional resource based industries. The bioassessment tool we are developing will allow us to determine the degree to which these activities are negatively impacting aquatic resources in the GYE.

Findings: Thus far, we have collected data from 47 streams and rivers in Yellowstone National Park, as well as over 50 streams in the GYE outside the Park. We have used these data to build a multivariate predictive model that accurately predicts the benthic invertebrate fauna of GYE streams. We assessed the accuracy of the prediction by measuring the ratio of observed (O) to expected (E) taxa (O/E score) at relatively pristine sites. The mean value of O/E for reference sites is 1.0, as would be expected if the model performs correctly. The standard deviation (SD) of the reference site O/E scores is a measure of model error. For our model, the SD of O/E scores is 0.128, which is quite good for these kinds of models. We are in the process of using the model to assess the biological integrity of 19 "test" streams in the GYE that are potentially impacted. The results of these analyses will help us to determine which land use activities may be having the greatest impact on aquatic resources in the GYE. In addition, we will be using these data to assess whether changes in stream biodiversity are adversely affecting stream ecosystem processes in an upcoming phase of the project.

Project title: Trace Element Content of Cervid Antlers

Principal investigator: Dr. Jack Kovach
Phone: 740-826-8241
Email: jkovach@muskingum.edu
Address: Geology Department
Muskingum College
New Concord, OH 43762

Objective: I am studying the strontium isotopic composition and the content of strontium and other trace elements in elk and deer antlers from selected national parks in the western U.S., including Yellowstone. The study will add to the general body of knowledge about the cycling of trace elements through the environment and increase our understanding of the biogeochemistry of strontium. The study will provide baseline data from which future changes may be gauged. (A copy of the research proposal which I submitted to the Green Educational Foundation [which has provided $12,017.00 for this study] is on file in the Research Office, Yellowstone Center for Resources, Mammoth Hot Springs, Yellowstone National Park. Said proposal provides a detailed description, etc. of this project.)

Findings: No significant findings to date inasmuch as no analytical data are yet available. Evidence of antler-chewing/osteophagia by Yellowstone elk has been obtained from several areas of Yellowstone's Northern Range, and such activities are likely related to the major and/or trace element content of the antlers/bones and the nutritional status of the elk. Much of my field work in the park in 2001 was directed toward determining the geographic distribution and frequency of occurrence of antler-chewing/osteophagic behavior through observations of skeletal remains of dead animals and cast (shed) antlers of elk and mule deer, mostly on Yellowstone's Northern Range.

Project title: A Remote Sensing and GIS-Based Model of Habitat as a Predictor of Biodiversity

Principal investigator: Dr. Diane Debinski
Phone: 515-294-2460
Email: debinski@iastate.edu
Address: Department of Animal Ecology
124 Science II
Ames, IA 50011

Additional investigators: Kelly Kindscher, Mark Jakubauskas

Objective: In 1992, we initiated an interdisciplinary project entitled "Modeling Spatial and Temporal Dynamics of Montane Meadows and Biodiversity in the Greater Yellowstone Ecosystem." Our research team has been developing predictive species assemblage models based upon landscape level habitat analysis (e.g., Debinski and Humphrey 1997; Debinski et al. 1999, 2000; Kindscher et al. 1998; Jakubauskas et al. 1996, 1998; Jakubauskas and Debinski 1995). The goal was to use intensive, local field sampling to extrapolate species distribution patterns within a region. The

hypothesis was that plant and animal locations could be predicted by analyzing spectral reflectance characteristics as recorded by satellite multispectral scanners. This research was originally conducted in the northwest corner of the Greater Yellowstone Ecosystem (GYE) and then expanded to the Grand Teton National Park in 1996. Grants from the U.S. Forest Service, the U.S. Park Service, the U.S. Environmental Protection Agency, and three universities have supported our work.

Findings: Our sampling sites were identified using remotely sensed classification of the montane meadow habitats. Six meadow types were identified using a GIS to stratify the study area by topography and geology. Field sampling was used to collect data on the distribution of plant, bird, and butterfly species. We sampled extensively for four summers (1997–2000) in two regions of the ecosystem: the northern region included the Gallatin National Forest and northwestern portion of Yellowstone National Park (Gallatins); the southern region included Grand Teton National Park (Tetons). These two regions are 192 km apart, but have very similar plant and animal communities. Twenty-five sample sites were located in the Tetons and thirty sample sites were located in the Gallatins during 1997. These were termed "core sites" and were sampled during each of the four years. Additional sites were added in later years (including up to 65 sites per region), but we have focused the efforts during 2001 on these core sites.

Our previous research showed that montane meadow communities can function as early indicators of environmental change because they are highly sensitive to variations in precipitation and temperature (Debinski et al. 1999, 2000; Kindscher et al. 1998; Jakubauskas et al. 1998). However, the rarity and low abundances of some of the species have limited our understanding of these patterns. Thus, additional data will allow us to expand upon our understanding of these groups as indicators. We believe that the plant, bird, and butterfly communities may be some of the best indicators of environmental change in the GYE. Continued surveys of the plant, bird, and butterfly taxa will allow us to quantify the year-to-year variation in species abundances and distribution patterns. These data are critical if we hope to differentiate between natural background fluctuations and real changes caused by climate change.

Other accomplishments: We are drafting a manuscript that summarizes the results of the work that we have been conducting on biodiversity assessment techniques using remotely sensed and on the ground data from 1997–2001 on birds, butterflies, and plants in GYE montane meadows.

We are finalizing a publication that summarizes the comparison of our biodiversity assessment techniques to that of the Wyoming and Montana GAP analysis work (Su et al.). Drs. Diane Debinski and James Pritchard finished their manuscript "A Complete Guide to Butterflies of the Greater Yellowstone Ecosystem" to be published by Roberts Rinehart Publishers. Dr. Debinski collaborated with Dr. Paul Opler, author of the Peterson's Guide to Butterflies, to create a current list of butterflies of Grand Teton National Park. This list will be linked to the Northern Prairie Biological Resources database on biodiversity across North America: http://www.npwrc.usgs.gov/resource/1999/insect/gteton.htm. The Northern Prairie Wildlife Research Center, which is part of the U.S. Geological Survey located in Jamestown, North Dakota, is compiling biodiversity data nationwide for this web page, and there were previously no listings for invertebrates of any kind in the Greater Yellowstone Ecosystem. Dr. Debinski's graduate student, Amanda Hetrick, designed a web site to describe our research in the GYE to the general public. It may be found here: http://www.public.iastate.edu/~ahetrick/prototype/homepage.html.